Typical Approach:

Electric Utility Distribution Planning

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Overview

- Distribution Planning Purpose
- Define Planning Areas
- Model the System and Understand Loads
- Forecasting Load Growth
- Normalizing Weather
- Establishing Planning Criteria
- Identifying Alternatives
- Approvals
- Challenges

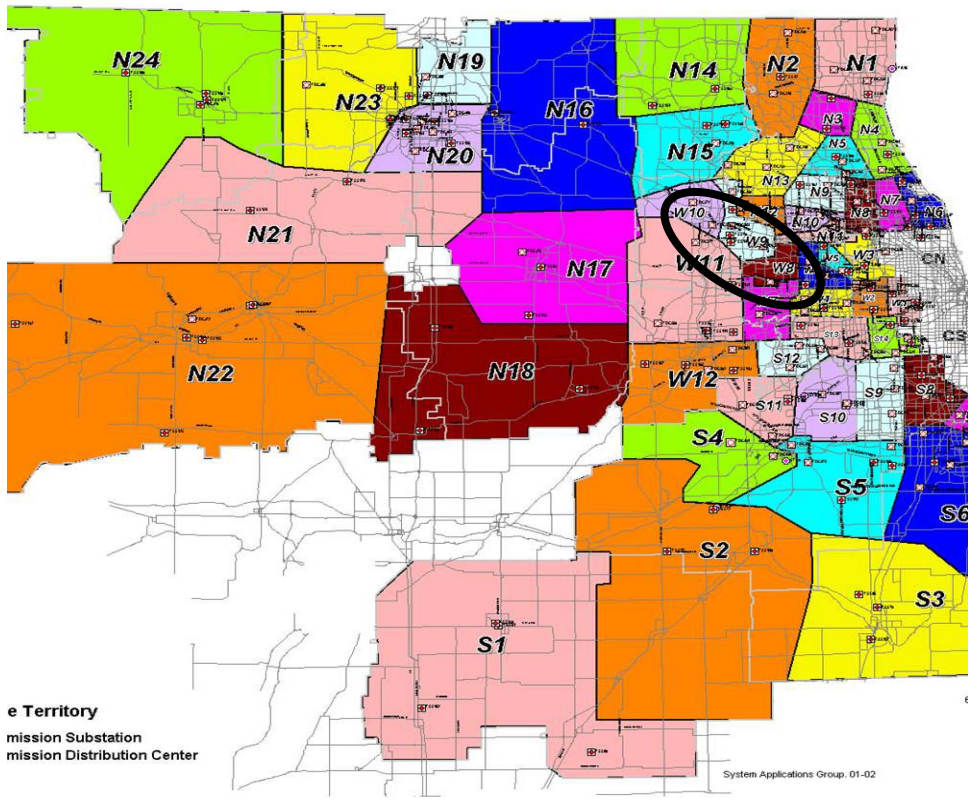
Distribution Planning Purpose

- Identifies electric power delivery deficiencies
- Typical forecast includes a10 year planning horizon
- Bound by a specified geography
- Results in:
  - Understanding of system capabilities and limitations
  - List of recommended projects required over time period
  - Understanding for:
    - Financial requirements
    - Long lead time materials
    - Right-of-Way Needs
    - Required permits
    - Community and State involvement

Define Planning Areas

- For a Defined Planning Areas
  - Analyze capacity and operability
  - Typically includes radial transmission, sub-transmission, substations and feeders
  - Requires review of all components

- Identify plans and alternatives by Planning Area considering:
  - Capacity
  - Load Growth
  - Operability
  - Reliability

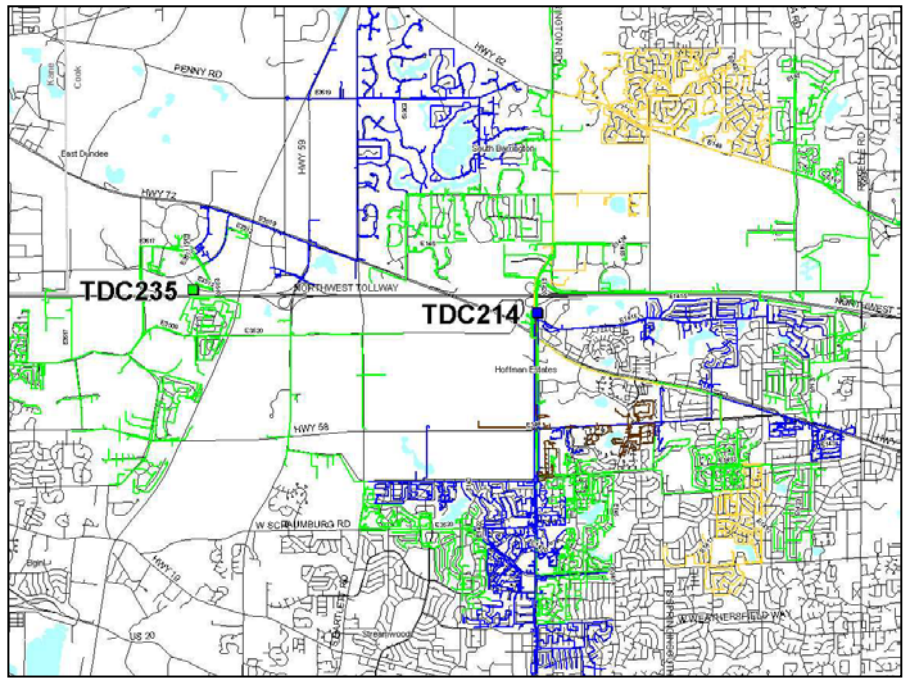


- Define Planning Area

Model the System and Understand Loads

- Model the System
  - Equipment
  - Protection
  - Connectivity
  - Tie points

- Understand Loads
  - Collect actual substation and feeder maximum peak loads
    - SCADA
    - Circle Charts
  - Ensure ‘normal’ configuration



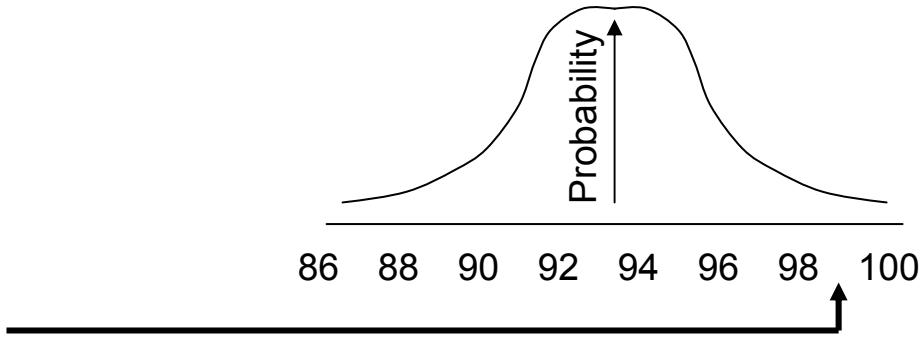
- Model the System
- Understand Loads
- Forecast Load Growth

Forecasting Load Growth

- Knowledge from employees in local offices
- Known large customer additions / expansions
- Forecasts from cities
- Maximum land use and load potential for area served
- Load growth trends
- Home start forecasts i.e. American Metro Study
- Correlation of system, substation and feeders load growth forecasts
  - Understanding of coincidence
  - Ensure consistency

Normalize for Weather Using 90/10

Peak Annual Four-Hour Temperature

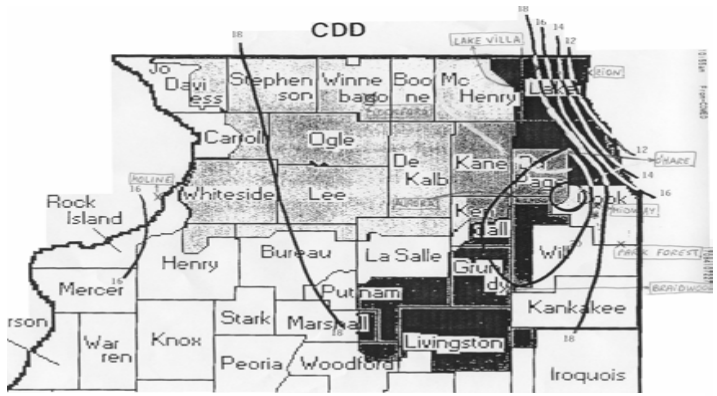


<u>Planning</u>

- Design to serve load conditions occurring ‘once in a decade’

<u>Operating</u>

- Forecast with multiple zones
- Model next-day during peaking conditions
- Make system adjustments
  - ✓ Switching
  - ✓ Load Control
  - ✓ Mobile Generation



Multiple weather zones may apply

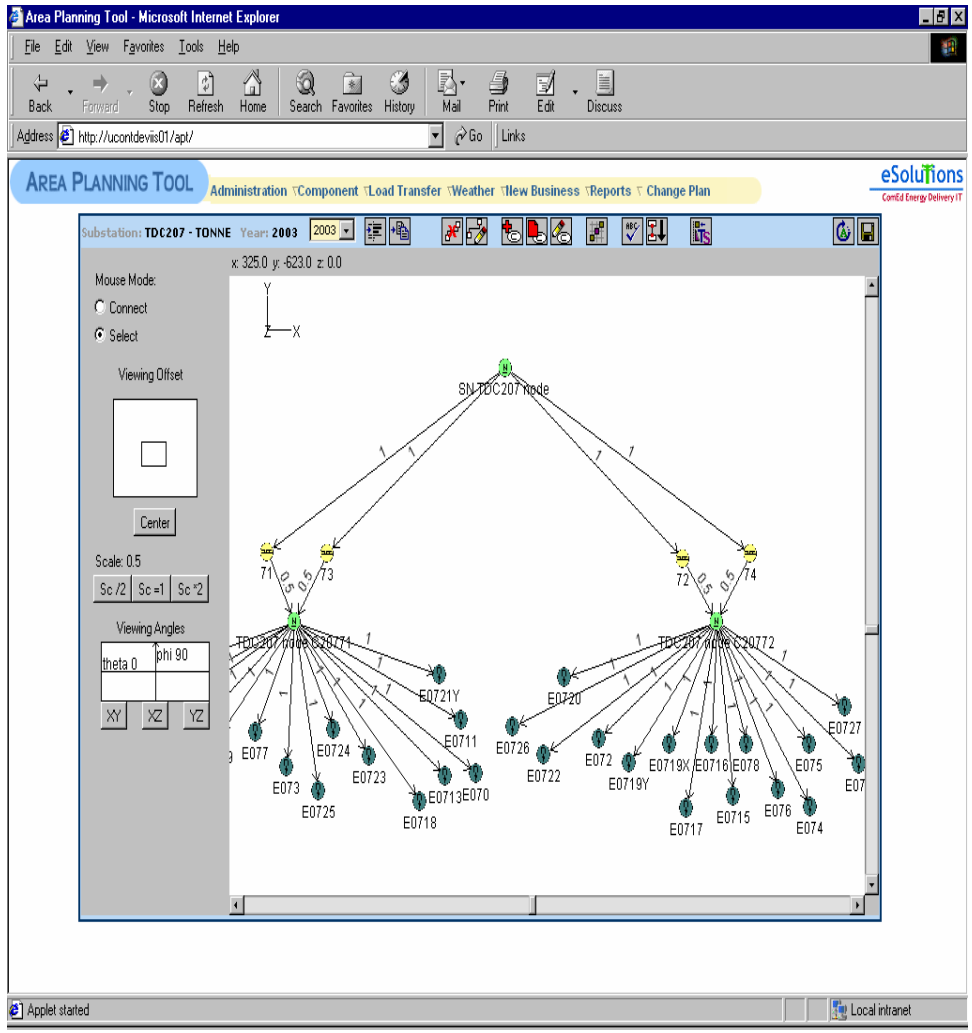
Applying Planning Criteria

- Performance standards defined for each component considering conductor size, type and operating voltage

- Influencing factors:
  1. Current limit: related to the ability of the facility to withstand heat
  2. Voltage limit: provide adequate voltage to customer premise
     - Usually at least 95% of nominal voltage on distribution
  3. Contingency Outage Capability
     - Single Contingency Protection: system will continue to operate within voltage and loading limits after the loss of a single element
       - Typically applies to substations and feeder mainlines
     - Double Contingency Protection: system will continue to operate within voltage and loading limits after the loss of two elements.
       - Typically applies to transmission facilities

Increase Efficiency with Systems

- Collect the actual peak load data
- Overlay forecasted new load and planned load transfers
- Graphically view and edit connectivity
- Perform “what-if” load analysis
- Edit connections using “drag-and drop” features
- Automate roll up of transformer and feeder loads to better calculate area load forecasts



Web based graphical tool and system model

Identifying Alternatives

- Select alternatives that solve forecasted problem
- Analyze implementation issues
  - Right-of-Way issues
  - Community restrictions
  - Duct size limitations
  - Substation exit restraints
  - Constructability
- Perform economic analysis on viable alternatives
- Select and develop expansion alternatives that minimize costs
- Incorporate short term reliability efforts in system expansion plan
- Manage the risk associated with load growth uncertainties

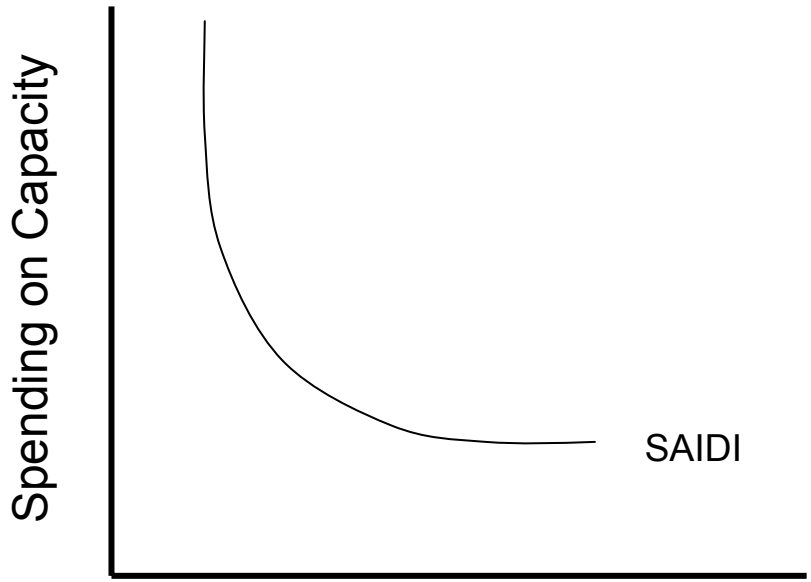
Typical Types of Work Identified

Capacity

- Line Extensions
- New Feeders
- New Substations
- Re-conductoring
- Substation upgrades
- Switching to Balance Load

Configuration

- Better switching alternatives
- Distribution automation
- Creating looped systems



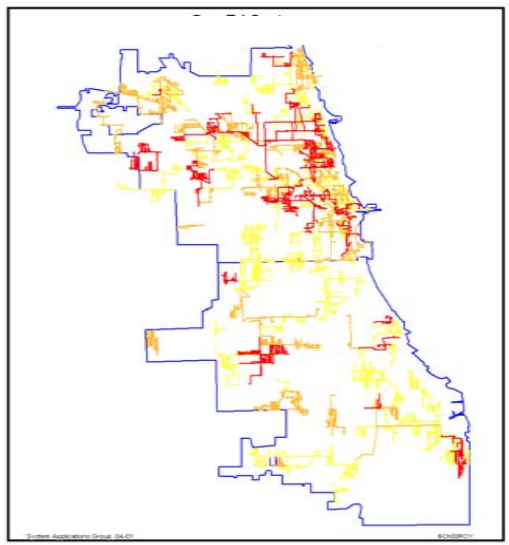
All points on the curve represent the same reliability (SAIDI) though they do not cost the same

Approval

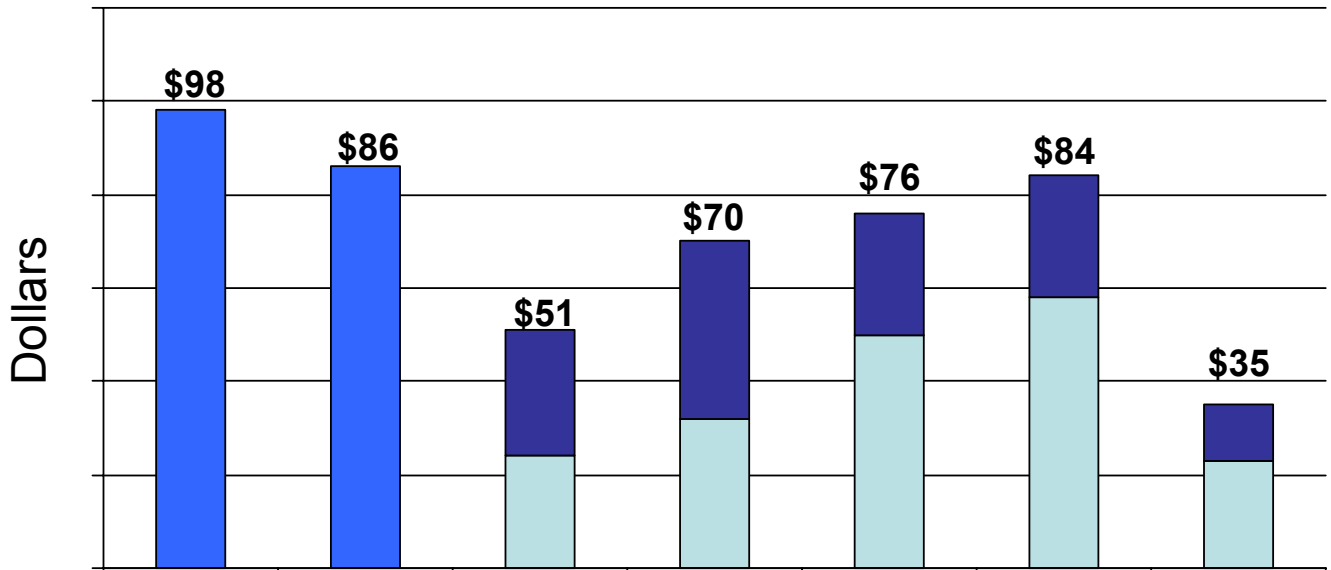
- Prioritize projects using forecasted overload severity

- Best practice:
  - Identify and approve projects 12 – 18 months in advance of peak
  - Make minor adjustments if peak loads are not as predicted
  - Facilitates:
    - Better planning
    - Increased productivity
    - Enhanced budget input

	Substations	Feeders
Red	≥ 110%	≥ 120%
Orange	≥ 105% and <110%	≥ 110% and <120%
Yellow	> 100% and <105%	≥ 105% and <110%



Typical Preliminary Capital Budget
Distribution Capacity



	2001A	2002F	2003	2004	2005	2006	2007
Substation and Feeder	98	86					
Feeder			27	38	26	26	12
Substation			24	32	50	58	23

Planning Estimate

A - Actuals
F - Forecast

Planner Challenges

- Accurate load forecasting
- Having accurate data to model the system
- Adjusting for normal configuration
- Adjusting for weather normalization
- Gathering accurate load information
- Keeping circuits balanced
- Ensuring coordination of protective devices
- Designing ties for contingency switching
- Aligning load forecasts
- Coordination with substation and transmission upgrades

Planner Challenges with Preferred Alternative

- Limits for duct availability
- Challenges to securing Right-of-Ways
- Resistance from community
- Limitations for securing outages to construct
- Constraints to exit substations
- Substations are limited for additional sources
- Ensuring completion by peak load season
- Communicating
  - ✓ The plan – for funding
  - ✓ The plan – for accurate engineering and construction
  - ✓ System risk associated with not expanding

Additional Planner Challenges

- Automated switching deployment
- *Contingency analysis for un-funded upgrade projects*
- Adjusting to incorporate local load shedding
- Incorporating localized generation
- Having systems to accommodate interconnections
- Relay changes to accommodate generation addition
- Internal coordination for technology deployment
  - ✓ Settings
  - ✓ Installation Coordination
  - ✓ Operations training to utilize according to the criteria
  - ✓ Interface with SCADA
  - ✓ Crew acceptance
  - ✓ Battery maintenance and on-going testing

Additional Planner Challenges

- Fast track load additions that impact the existing plan
- Changing characteristics of existing load

Operation Challenges

- Maintaining configuration during peak loads
- Gathering load data (if not available automatically)
- Scheduling switching to provide outages for construction
- Operating using planning assumptions
- Entering information for system additions
- Dispatching to minimize outage duration

Conclusions

Distribution Planning -

- *is a year round process*
- *not an exact science*
- *results in a range of possible load situations*
- *includes loading and operating issues*
- *provides the bottom up load projection for the system*
- *is focused on individual circuits*